FEMA 1.209:210132

FLOOD INSURANCE STUDY

CITY OF BARBOURVILLE, KENTUCKY

KNOX COUNTY

SEPTEMBER 6, 1989

Federal Emergency Management Agency

COMMUNITY NUMBER 210132

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
1.1	Purpose of Study	1
1.2	Authority and Acknowledgments	1
1.3	Coordination	2
2.0	AREA STUDIED	2
2.1	Scope of Study	2
2.2	Community Description	2
2.3	Principal Flood Problems	2
2.4	Flood Protection Measures	4
3.0	ENGINEERING METHODS	4
3.1	Hydrologic Analyses	4
3.2	Hydraulic Analyses	5
4.0	FLOODPLAIN MANAGEMENT APPLICATIONS	6
4.1	Floodplain Boundaries	7
4.2	Floodways	7
5.0	INSURANCE APPLICATION	8
6.0	FLOOD INSURANCE RATE MAP	10
7.0	OTHER STUDIES	10
8.0	LOCATION OF DATA	11
9.0	REFERENCES AND BIBLIOGRAPHY	11

TABLE OF CONTENTS (continued)

Page

FIGURES

Figure 1 - Vicinity Map 3

Figure 2 - Floodway Schematic 8

TABLES

Table 1 - Summary of Discharges 5

Table 2 - Floodway Data 9

EXHIBITS

Flood Profiles

Cumberland River Panel 01P
Richland Creek Panel 02P

Flood Insurance Rate Map

Elevation Reference Marks

FLOOD INSURANCE STUDY

CITY OF BARBOURVILLE,
KNOX COUNTY,
KENTUCKY

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study revises and supersedes a previous Flood Insurance Study for the City of Barbourville, Knox County, Kentucky (Reference 1). This information will be used by the community to update existing floodplain regulations as part of the regular phase of the National Flood Insurance Program. The information will also be used by local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the National Flood Insurance Program are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some states or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the state (or other jurisdictional agency) will be able to explain them.

This Flood Insurance Study was prepared by compiling existing hydrologic and hydraulic technical and scientific data prepared originally for purposes other than the National Flood Insurance Program. The data were identified as applicable at the time of compilation of this Flood Insurance Study and should depict the general conditions of the flooding sources with relative accuracy. The Federal Emergency Management Agency (FEMA) performed a cursory review and accepted the data as valid for purposes of this Flood Insurance Study and the National Flood Insurance Program. However, if better information is known to exist or has been developed since the date of this report, the information should be immediately forwarded to the Natural and Technological Hazards Division, FEMA, Atlanta, Georgia, for consideration for revision of this study.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were obtained from the U.S. Army Corps of Engineers, Nashville District, "Upper Cumberland River Basin Local Protection Project Barbourville, Kentucky" (Reference 2).

1.3 Coordination

On April 27, 1988, the results of this Flood Insurance Study were reviewed and accepted at a final coordination meeting attended by representatives of the community and FEMA.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the City of Barbourville, Knox County, Kentucky. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected based on the extent and validity of available existing hydrologic and hydraulic data.

Flooding caused by overflow of the Cumberland River and Richland Creek was studied in detail.

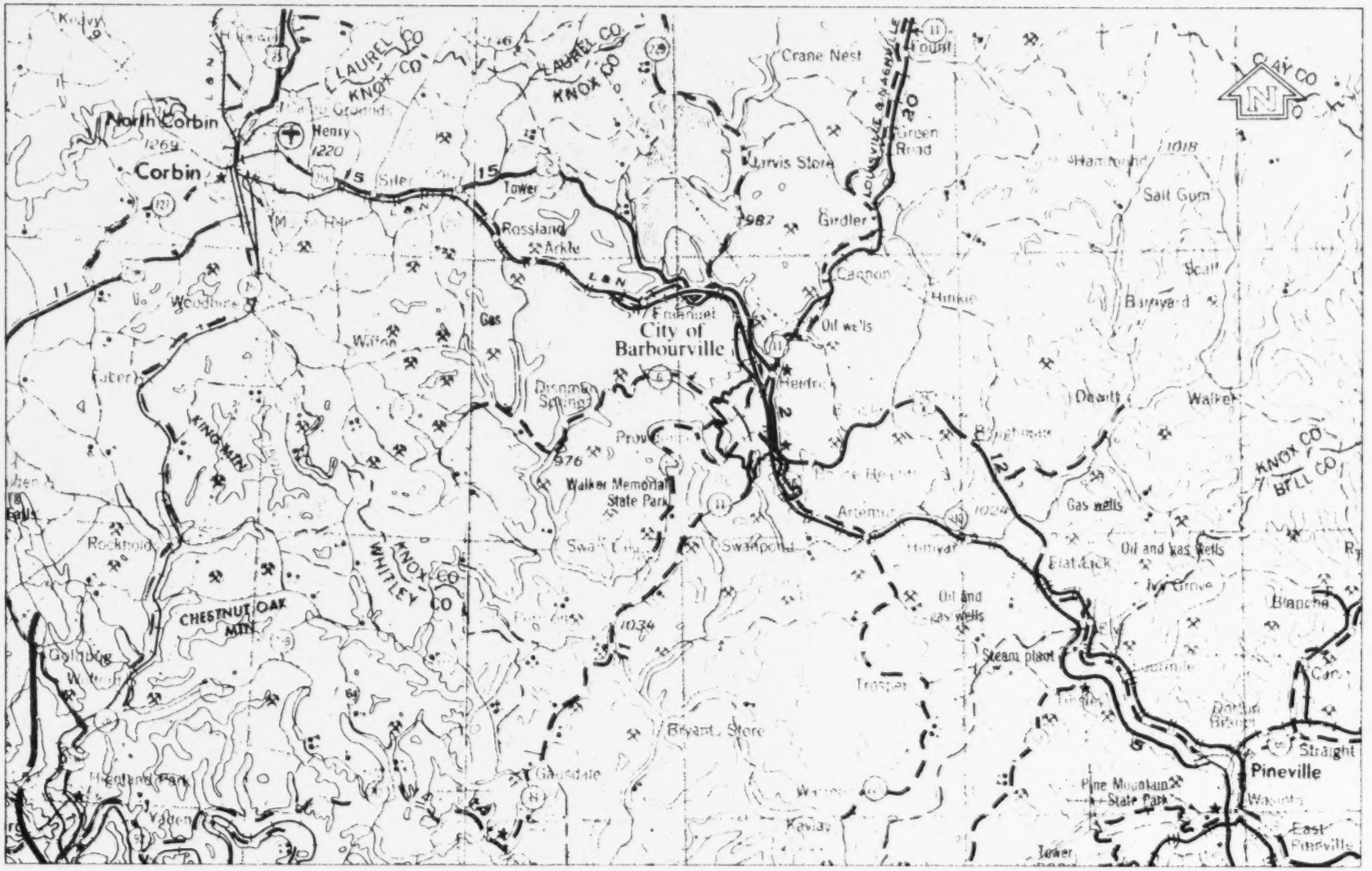
2.2 Community Description

The City of Barbourville is the county seat of Knox County, Kentucky, and is located at the confluence of the Cumberland River and Richland Creek, approximately 15 miles southeast of the City of Corbin, Kentucky. Barbourville lies in the Cumberland River floodplain approximately 60 miles downstream of the origin of the river at the confluence of Poor and Clover Forks near Harlan, Kentucky. The city is served by the CSX railroad and State Routes 6, 11, and 225. The 1980 population of Barbourville was reported to be 3,333 (Reference 3).

The Upper Cumberland River Basin has a temperate climate with relatively cold winters and hot, humid summers. The mean annual temperature is 56 degrees Fahrenheit (^{o}F). Temperature extremes range from approximately 20 degrees below zero to a few degrees above 100. Average monthly temperatures range from about 75 ^{o}F in July to about 36 ^{o}F in January. All seasons are marked by weather changes that come from passing weather fronts and associated centers of high and low pressure (Reference 2).

2.3 Principal Flood Problems

The widespread and intense rainstorm of April 3-6, 1977, produced flooding on nearly all streams in the Upper Cumberland River basin. A succession of converging cold fronts and moist warm fronts caused extensive rainfall over Tennessee, Kentucky, and western Virginia. The critical period of the storm occurred from 6 pm on April 3 until midnight on April 4. The storm produced the flood of record at all mainstem Cumberland River cities upstream of Cumberland Falls. For example, at Harlan, 60 miles upstream of Barbourville, and at Pineville, 18 miles upstream of Barbourville, the previous floods of record were exceeded by 4.8 and 4.3 feet, respectively. At Barbourville, the river crested 3.1 feet above the previous January 1946 flood of record (Reference 2).


North Corbin
Corbin
Henry
1220
1269
LAUREL CO
KNOX CO
Crane Nest
Jarvis Store
Girdler
Rossland
Arkle
Tower
Gas
City of
Barbourville
Oil wells
Walker Memorial
State Park
Walker
Salt Gum
Barnyard
Gas wells
Oil and gas wells
Steam plant
Bryant Store
Pine Mountain
State Park
Pineville
East
Pineville
Straight
Creek
CLAY CO
BELL CO
WHITLEY CO
CHESTNUT OAK
MTN
KING MTN
Rockhold
Swamp Old
Artemus
Flat Lick
Ivy Grove
Branche
Tower
Keavy
Gaysdale
Headley Park
Valley
Gatliff
Rocky
Brush
Creek
Laurel
Fork
Rocky
Fork
Dismal
Spring
Prov
Swamp
Creek
Laurel
Creek
Rocky
Brush
Creek
Rocky
Fork
Laurel
Fork
Laurel
Creek
Rocky
Fork
Laurel
Creek
Rocky
Fork
Laurel
Creek
Rocky

2.4 Flood Protection Measures

The City of Barbourville is currently protected by an earthen levee and appurtenant facilities. A floodwall has been constructed on top of the existing levee from 800 feet downstream of State Route 11 to 2,000 feet upstream of State Route 11. Downstream of the State Route 11 bridge, the wall is 8 feet high; upstream of the bridge, the wall is 12 feet high. The levee provides protection for the city from the 100-year flood event.

Downstream of Barbourville, a 5,000-foot diversion channel has been constructed. The diversion channel will cause water to bypass several miles of the Cumberland River natural channel and will lower the maximum flood elevations in the city. The diversion channel invert is 25 feet above the streambed of the Cumberland River, making it operative only during periods of high flow. The invert had to be low enough to divert flow away from the existing channel but high enough to minimize the aggradation/degradation of the section of river channel affected by the diversion. The optimum invert elevation was determined to be approximately the 5-percent exceedence water-surface elevation of the river, i.e., the diversion channel operates approximately 5 percent of the time each year (Reference 2).

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 100-year flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each riverine flooding source studied in detail affecting the community.

The original unit hydrograph used for the Cumberland River was developed prior to the construction of the existing levee according to the procedures outlined in Civil Works Investigations - Project 152 (Reference 2). Three historical flood-discharge hydrographs, for the floods of January 1970,

November 1973, and April 1977, were used in the derivation of the adopted unit hydrograph. That hydrograph was defined by averaging the unit hydrograph ordinates derived for each event. The validity of using the adopted unit hydrograph was verified when it was found that the hydrograph could be used to accurately reproduce the three largest floods of record that have occurred at Barbourville since completion of the existing levee.

The unit hydrograph for Richland Creek was based upon Snyder's constants developed for Yellow Creek at Middlesboro, Kentucky. Yellow Creek is a stream with a drainage basin very similar to that of Richland Creek, and its unit hydrograph has reproduced three of the larger floods on Yellow Creek. The Snyder's constants used agreed closely with Snyder's constants developed at other locations in the Upper Cumberland River basin.

The adopted unit hydrographs were applied to the rainfall excess and produced peak discharges of 115,000 and 26,000 cubic feet per second (cfs) for the Cumberland River and Richland Creek, respectively.

Peak discharge-drainage area relationships for the 100-year floods for each flooding source studied in detail in the community are shown in Table 1.

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQ MILES)	PEAK DISCHARGE (CFS) 100-YEAR
CUMBERLAND RIVER just downstream of State Route 11	960	68,000
RICHLAND CREEK at confluence with the Cumberland River	74.1	12,000

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles.

The HEC-2 computer program was used to establish flood profiles (Reference 4). Cross sections were obtained from field survey. The backwater model was calibrated by adjusting the cross-section geometry to accurately define effective flow area and by adjusting Manning's roughness coefficients to reproduce the January 1970 and the April 1977 flood profiles.

The resulting Manning's "n" values were 0.045 to 0.053 for the channel and 0.10 for the overbanks.

The 100-year flood profile for the Cumberland River was determined using two backwater models in conjunction: the existing model, modified to reflect the floodwall, and a new model for the diversion channel, with Mannings "n" values of 0.035 and 0.10 for the channel and overbanks, respectively. At the upstream junction of the river and the diversion channel, the contraction and expansion losses were increased to account for turbulence.

Backwater computations were started 4.4 miles downstream of the diversion channel. Using a discharge of 115,000 cfs, the two models were used in conjunction to determine the flow/elevation balance and the 100-year flood profile. A sensitivity analysis was performed on the flow distribution to determine the effects of less flow entering the diversion. That analysis showed that if the flow distribution was off by 50 percent, flood heights would not increase by more than 1.5 feet at the Barbourville gage. The 100-year flood is not contained within the diversion channel; however, because the diversion channel reduces maximum flood elevations, the 100-year event does not flood additional lands. Furthermore, the possibility of a slight rise in water-surface elevations due to the existing levee is more than offset by the flood elevation reductions provided by the diversion channel. Because of the large amount of flow area in the low left overbank, the State Route 11 bridge does not constrict the flows.

In the absence of streamflow records, the magnitude and timing of floods on Richland Creek were determined by centering 100-year storms over the Cumberland River basin above Barbourville. The profile was greatly influenced by the Cumberland River elevation at the mouth of Richland Creek. As a result, the water-surface slope was very flat through the levee reach.

Areas of the community protected by levees are subject to potential risk due to possible failure or overtopping of the levee. These areas were delineated by applying the 100-year elevation determined from the "levee in place" analysis.

The hydraulic analyses for this study are based on the effects of unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the map and described in the exhibit labeled Elevation Reference Marks.

4.6 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound floodplain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year

floodplain boundaries and 100-year floodway to assist communities in developing floodplain management measures.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent annual chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent annual chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the 100- and 500-year floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:24000 with a contour interval of 20 feet (Reference 5).

The 100- and 500-year floodplain boundaries are shown on the Flood Insurance Rate Map. On this map, the 100-year floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, AO, A99, V, and VE) and the 500-year floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 100- and 500-year floodplain boundaries are close together, only the 100-year floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

Some areas of the community that are protected from the 500-year flood by a levee have been delineated as having potential risk due to possible failure or overtopping of the levee during larger floods.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces the flood-carrying capacity, increases the flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways for this study were computed for certain stream segments on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections,

the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections and are shown in Table 2, Floodway Data. The computed floodways are shown on the Flood Insurance Rate Map. In cases where the floodway and 100-year floodplain boundaries are either close together or collinear, only the floodway boundary is shown. Portions of the floodway for Richland Creek lie outside the corporate limits.

Along streams where floodways have not been computed, the community must ensure that the cumulative effect of development in the floodplain will not cause more than a 1.0-foot increase in the base flood elevations at any point within the community.

The area between the floodway and the 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

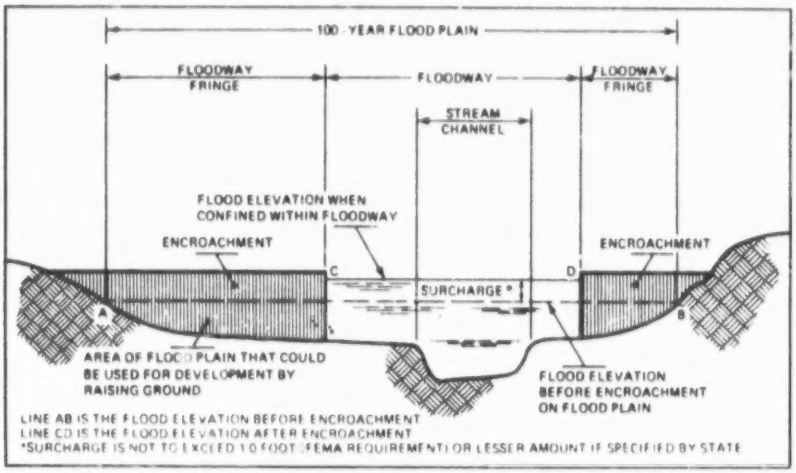

100 - YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE *
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE AB IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE CD IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE IS NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE

FIGURE 2 - Floodway Schematic

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone *A*

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
RICHLAND CREEK								
A	0.18	104	2298	5.2	986.0	967.8[3]	968.8	1.0
B	0.36	141	2134	5.6	986.0	968.6[3]	969.6	1.0
C	0.72	107	2250	5.3	986.0	970.5[3]	971.3	0.8
D	0.91	140[2]	2773	4.3	986.0	971.1[3]	972.1	1.0
E	1.39	154[2]	2962	4.3	986.0	972.9[3]	973.8	0.9
F	1.84	142[2]	1951	6.2	986.0	973.0[3]	974.0	1.0
G	2.18	414[2]	4864	3.2	986.0	974.0[3]	974.8	0.8
H	2.77	345[2]	5734	2.6	986.0	974.7[3]	975.6	0.9
I	3.10	409[2]	7124	2.1	986.0	975.0[3]	976.0	1.0
J	3.48	148[2]	2232	5.4	986.0	975.0[3]	976.0	1.0

[1]MILES ABOVE CONFLUENCE WITH CUMBERLAND RIVER
[2]THIS WIDTH EXTENDS BEYOND CORPORATE LIMITS
[3]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM THE CUMBERLAND RIVER

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BARBOURVILLE, KY
(KNOX CO.)

FLOODWAY DATA

RICHLAND CREEK

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study by detailed methods. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually areas of ponding) where average depths are between 1 foot and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 100-year floodplain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols the 100- and 500-year floodplains, the floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

7.0 OTHER STUDIES

A published report on local protection projects for the City of Barbourville area (Reference 2) is in agreement with this report.

The Flood Insurance Study for Knox County, Kentucky (Reference 6) is in agreement with this study.

This Flood Insurance Study supersedes the previously printed Flood Insurance Rate Map for the City of Barbourville (Reference 1).

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, 1371 Peachtree Street, NE., Suite 736, Atlanta, Georgia 30309.

9.0 REFERENCES AND BIBLIOGRAPHY

1. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Study, City of Barbourville, Knox County, Kentucky, December 1977.

2. U.S. Army Corps of Engineers, Nashville District, Upper Cumberland River Basin Local Protection Project, Barbourville, Kentucky, October 1984.

3. U.S. Department of Commerce, Bureau of Census, 1980 Census of Population, Number of Inhabitants, Kentucky, Washington, D.C., February 1982.

4. U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-2 Water Surface Profiles, Computer Program 723-X6-L202A, Davis, California, April 1984.

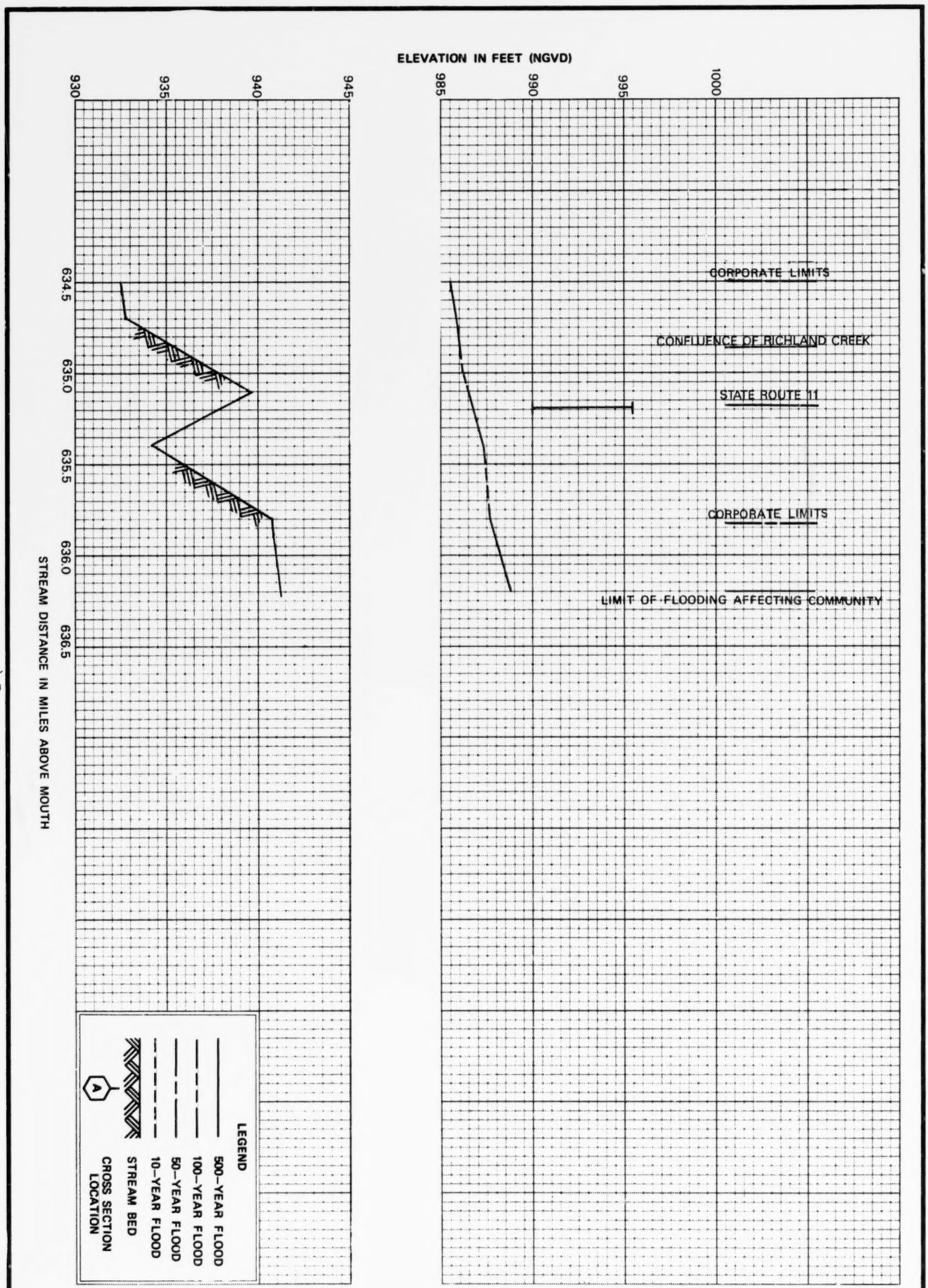
5. U.S. Geological Survey, 7.5 Minute Series Topographic Maps, Scale 1:24000, Contour Interval 20 Feet: Barbourville, Kentucky, 1974.

6. Federal Emergency Management Agency, Flood Insurance Study, Knox County, Unincorporated Areas, Kentucky, May 1989.

ELEVATION REFERENCE MARKS

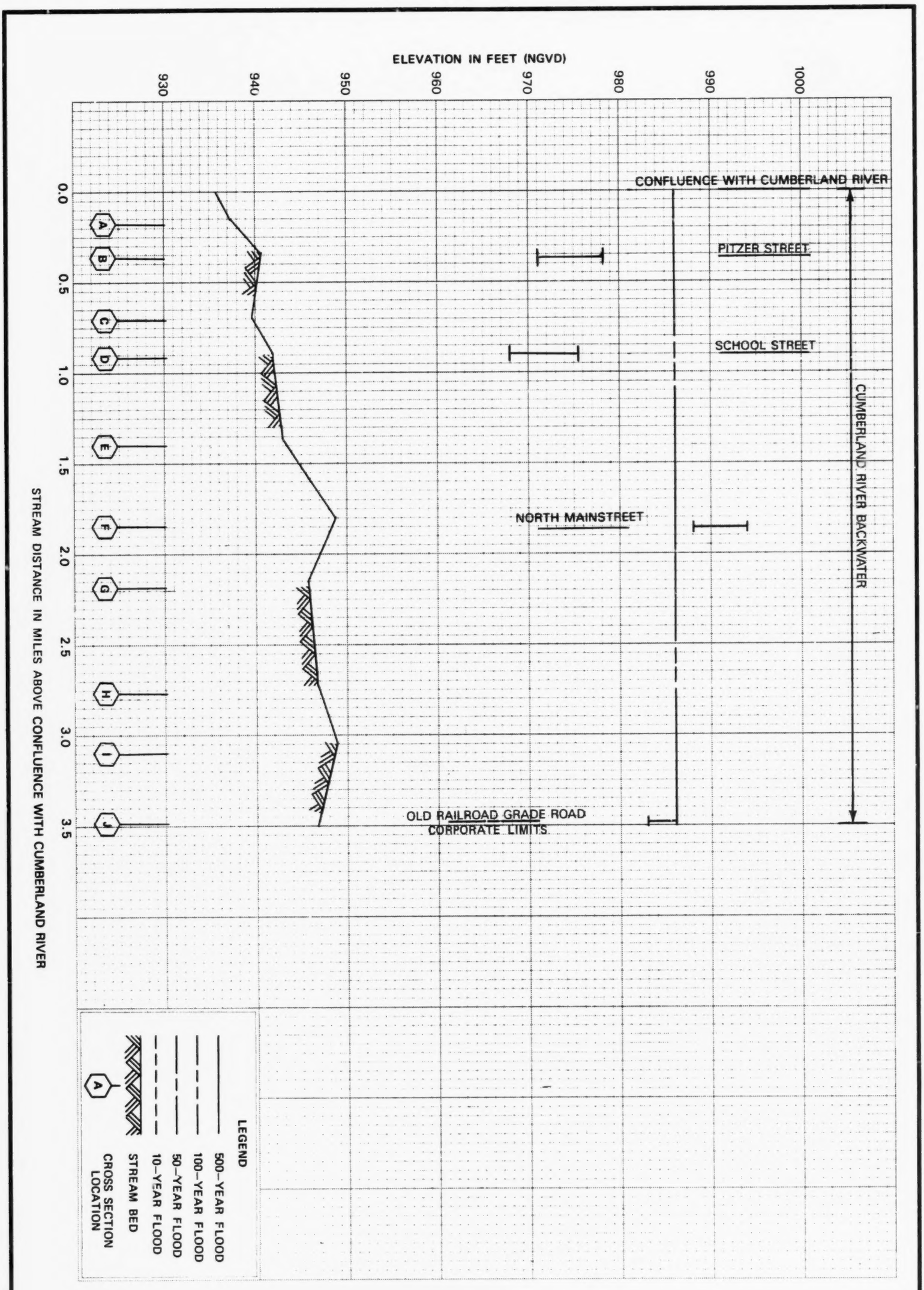
REFERENCE MARK	FLOOD INSURANCE RATE MAP PANEL	ELEVATION (FEET NGVD)	DESCRIPTION OF LOCATION
1	0002	988.16	chiseled square on southwest corner of gate valve operating station located about 920 feet southwest along levee from State Route 11 bridge over the Cumberland River
2	0001	989.00	chiseled square on north flood gate of Pitzer Street, 1 foot west of flood gate entrance, about 150 feet northeast of Pitzer Street bridge over Richland Creek
3	0001	988.53	chiseled square on northwest corner of operating valve box located 600 feet along levee southeast of School Street
4	0001	990.60	railroad spike in power pole located 400 feet northeast of School Street bridge over Richland Creek, about 35 feet east of levee
5	0001	994.01	chiseled square on northeast corner of North Main Street bridge over Richland Creek
6	0001	993.06	chiseled cross in southwest metal guard post located 100 feet along levee west of Barner Lane
7*	0001	985.96	chiseled square in southeast corner of concrete overpass, 200 feet southeast of U.S. Route 25 East along Manchester Street from eastbound U.S. Route 25
8	0001	978.96	PK nail in base of cable corner post located 1,000 feet along levee east of North Main Street bridge over Richland Creek

*outside corporate limits



(3)

01P	FEDERAL EMERGENCY MANAGEMENT AGENCY **CITY OF BARBOURVILLE, KY** (KNOX CO.)	**FLOOD PROFILES** **CUMBERLAND RIVER**



02P	FEDERAL EMERGENCY MANAGEMENT AGENCY **CITY OF BARBOURVILLE, KY** (KNOX CO.)	**FLOOD PROFILES** **RICHLAND CREEK**